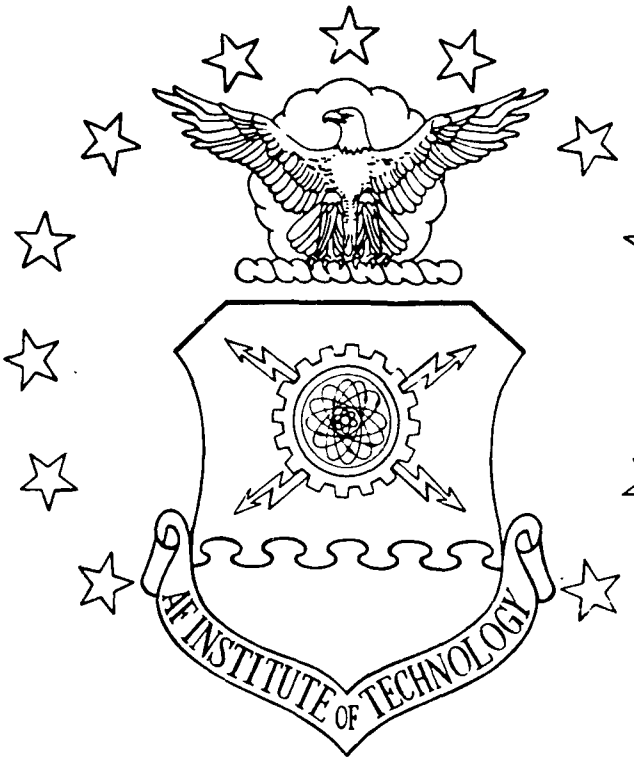

INVENTORY MANAGEMENT IN A UNITED STATES AIR FORCE REGIONAL MEDICAL CENTER PHARMACY

THESIS

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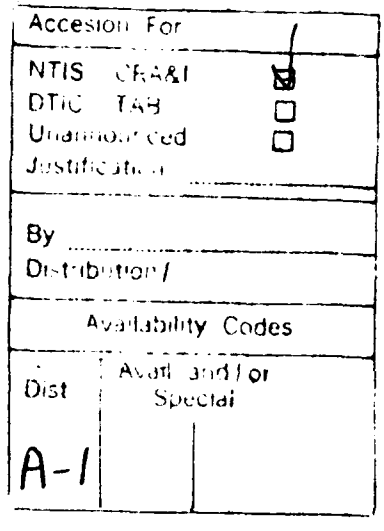

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THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

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Timothy R. McGee

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Abstract

The purpose of this case study was to examine outpatient pharmacy services at USAF Medical Center, Wright-Patterson AFB and identify ways of improving service to patients by improving inventory management. Research was also conducted at USAF Medical Center, Keesler AFB to contrast inventory management practices between the two facilities.

A review of the literature identified a variety of pharmacy management techniques as well as inventory management techniques in general. Interviews of base level and higher headquarters staff personnel were used to gather data for the study. Additionally, an ABC Inventory Analysis was performed to identify high dollar volume inventory items which may merit closer management attention.

The procedures for identifying inventory requirements are examined. Inventory ordering, storage, and delivery practices are documented. The interfaces between medical materiel supply and its various sources of supply are outlined. The chain of supply was studied from the commercial origin of supplies, through the supply pipelines to the pharmacy, and, ultimately, to the patient.

Conclusions and recommendations are offered concerning management policies, inventory management procedures, order transmittal and inventory delivery. Suggested uses of ABC Inventory Analysis results are provided. Finally, some recommendations for future research are offered.

INVENTORY MANAGEMENT IN A UNITED STATES AIR FORCE REGIONAL MEDICAL CENTER PHARMACY

I. Introduction

General Issue

In 1988, pharmacy managers at USAF Medical Center, Wright-Patterson, began an effort to improve service to outpatients. Patients presenting prescriptions to the outpatient pharmacy wait an average of thirty minutes for prescriptions to be processed and filled, while USAF guidance indicates that an average waiting time of twenty minutes may be more appropriate (25). Some USAF health care facilities are tasked with maintaining even shorter average waiting time standards. For example, the Tactical Air Command goal is to "maintain an average waiting time for prescription service of less than 10 minutes for 80% or more of patients" (2). But, other facilities have experienced far greater waiting times than the Wright-Patterson pharmacy. At one USAF regional hospital, waiting times range from fifteen minutes during the slower summer months, to a one-hour one-hour waiting time during the busy winter months (13). While some improvement in prescription service time may reasonably be expected at the Wright-Patterson pharmacy, it is evident that current waiting times do not necessarily represent a worst case.

Several factors contribute to the pharmacy's ability to serve its customers. Among those factors, the budget has the most profound impact. With no funds available in its medical supply account, the pharmacy would be unable to restock with medications, even though the needed items may be physically available on the shelves of the medical center's medical materiel warehouse. The funds used by the materiel manager to maintain warehouse inventories come from the centrally controlled USAF Medical-Dental Stock Fund. Hence, supplies cannot legally be issued from the warehouse to the pharmacy without simultaneous reimbursement from the locally managed operations and maintenance funds allocated to the pharmacy. An extreme example of the problem caused by funds shortages occurred at the end of fiscal year 1988. During one day, 225 of the 800 patients presenting prescriptions to the pharmacy were turned away due to stock depletion (44). To prevent similar shortages from recurring, the medical center commander directed his resource management office to always load sufficient funds in the pharmacy's medical supply account (25).

Inventory management practices also affect service provided to patients. Virtually all pharmacy supplies are obtained from the medical materiel management section. Medical materiel management supports all medical center sections as well as twelve detached Army and Air Force

National Guard and Reserve units (40). The pharmacy supply custodian manually computes weekly order quantities and prepares an order list using a Wang microcomputer system. Medical materiel technicians input the orders from the pharmacy list into the Medical Logistics (MEDLOG) computer system. Orders are processed and deliveries of available items are made within two to three days (25). Backordered items can cause an out of stock condition in the pharmacy to persist for several consecutive months. For example, one item was backordered for six months, even though it was available on the local economy. Compounding the problem, the supply system's software, detecting no issues of the item during the six month backorder period, systematically decreased the stock control level for the item from a quantity of 120 to 72 (4).

A third factor affecting the pharmacy's ability to serve patients is manning and manpower utilization. Of the forty-nine personnel requirements earned by the pharmacy, only thirty-one are currently funded, and twenty-six personnel are assigned. With eight projected personnel losses and three projected gains, the number of personnel assigned is expected to dip well below half the number justified by the pharmacy manpower standard. Red Cross volunteers help offset the manpower deficit by performing certain non-prescription-filling functions within the pharmacy (25).

Efforts to improve outpatient pharmacy service have received top-level support. The medical center commander asked the Air Force Institute of Technology for consultant assistance. A medical center process action team was tasked with identifying ways to improve pharmacy service. The commander, Air Force Logistics Command, became personally involved in studying the issue.

Since the pharmacy is used by almost everyone entering the medical center, potentially thousands of patients will realize the benefits, if service is improved. In addition, the government will benefit from more efficient management practices. Further, patients who present prescriptions may return to work sooner if prescription waiting times are reduced.

The management question to be answered by this study is, "How can outpatient pharmacy service be improved at USAF Regional Medical Center, Wright-Patterson?"

Statement of the Problem

This study attempts to answer two research questions: "What is the quality of outpatient pharmacy services at USAF Medical Center, Wright-Patterson?" and "How can the area of pharmacy inventory management be improved?"

Scope of Research

Research will be limited to appraising the quality of service provided by the outpatient pharmacy, and attempting

to identify areas of inventory management that can be improved. Manning, manpower utilization, and work flow within the pharmacy will not be addressed, except as they relate to inventory management. The primary focus will be on the outpatient pharmacy. Other operations, such as the inpatient pharmacy and the pediatric pharmacy, will not be specifically addressed, although many of the same recommendations could be used in those areas.

Conclusions from this research will be based upon observed conditions at the pharmacy being studied as well as upon a literature review and comparison of performance indicators to those of one other USAF medical center pharmacy, USAF Medical Center Keesler. No attempt will be made to generalize findings to a broader population of USAF pharmacies.

Investigative Questions

A series of eight investigative questions will be used to direct the study toward answering the two research questions. The first three questions relate to the quality of pharmacy service and the remainder address inventory management.

The following are the investigative questions to be answered by this study:

1. What are the current inventory management policies as reflected on pharmacy inspection inspection checklists?

2. What internal and external factors contribute

to the quality of outpatient pharmacy service?

3. How do internal and external factors at USAF Medical Center, Wright-Patterson, compare to those at USAF Medical Center, Keesler?

4. What procedures does the outpatient pharmacy use to manage its inventory?

5. How can inventory ordering procedures be improved?

6. How can manual steps in the ordering process be eliminated or automated using existing equipment?

7. How can inventory delivery times be reduced?

8. Which items account for the greatest proportion of budget expenditures?

Organization of Thesis

Chapter II of the thesis is a literature review. Chapter III outlines the methodology used in conducting the study, and a discussion of findings is presented in Chapter IV. Finally, Chapter V contains conclusions and recommendations.

II. Literature Review

Overview

This chapter reviews the literature related to pharmacy management from a variety of perspectives. Thirteen of the articles address purchasing and inventory management, ten in hospital pharmacies and three in other settings. Seven articles deal with automation in the pharmacy. One article gives an account of a pharmacy design process, including inventory management considerations. One article describes pharmacy services in a US Army field hospital. Two articles address pharmacy personnel issues, four articles describe pharmacy cost management, and the final article outlines a pharmacy quality assurance program.

Purchasing and Inventory Management

Harrington described various inventory control techniques for reducing carrying costs and improving customer service. One technique involves analyzing consumption rates to identify excess inventory and decide whether it is more economical to keep it or dispose of it and save carrying costs (18:41-45). Another approach is to perform an ABC inventory analysis, a classification of products by dollar volume. The highest dollar volume items, typically ten to twenty percent of the items, are identified in the "A" category and are managed more closely

than other items. "A" items account for seventy to eighty percent of the dollar volume, and create the most cost for the company. The lower fifty to sixty percent of the items are identified in the "C" category, but represent only five to ten percent of the dollar volume. "B" items are categorized between "A" and "C" (18:42).

Harrington also describes the time-phased order point plan, which allows inventory managers to schedule arrivals of replenishment stocks according to forecasting results for uneven demand. Traditional reordering techniques are based on an inventory reorder point established by calculating average demand, leadtimes, and safety stock margins. The time-phased order point plan, on the other hand, revolves around determining when the company will need to receive the inventory required to fill orders. Distribution managers can then schedule materials receipt according to projected-need dates. Distribution Requirements Planning (DRP) uses time-phased order point methods, and helps a firm determine inventory needs at branch warehouses (18:42-43).

Another article advocates the use of an ABC inventory classification system for identifying key inventory items. The MIN-MAX inventory control system is also described. Under a MIN-MAX system, stock is ordered when inventory drops to a minimum level. The quantity ordered is just enough to return inventory to a maximum level (26:69-71).

Bruce Heydt describes various automated inventory control methods (19:69-70). Heydt states that an effective inventory control system must have access to a large amount of data, and system users must have access to the system via an adequate number of terminals (19:69). He suggests that the most desirable systems, are those that allow inventory managers to modularly upgrade software without losing historical data. Heydt further describes the benefits of one inventory management system that can be upgraded to include distribution resources planning (DRP) which integrates warehouse operations with forecasting, transportation, and scheduling activities (19:69-70).

Milton W. Skolaut and James C. McAllister, III, discuss pharmacy trends. One important trend mentioned is the tendency for Pharmacy and Therapeutics Committees to eliminate expensive drugs from the hospital formulary when lower cost items are equally effective (39:523). They attribute the substantial increase in drug costs to the federally mandated drug approval process. Drugs receive a seventeen-year patent life, but typically only five to seven years remain after the testing and approval process. This leaves manufacturers a shorter time over which to distribute research and development costs (39:525).

The increasing acceptance of medical materials management as a distinct hospital function is described by James C. McAllister III. McAllister points to 1979 as the

year when two significant reports found that less-than-optimal hospital pharmacy purchasing and inventory control was a problem of nationwide scale (29:320-322).

Jan N. Bair and Gordon F. Lee offer suggestions for developing or modifying a pharmacy purchasing system. Bair and Lee urge pharmacists to understand the operation of the purchasing systems that support them, and be prepared to participate in their development (1:1574).

Daniels presents the management functions of planning, organizing, directing, and controlling in relation to hospital pharmacy inventory control. Inventory management tasks are listed for each function of management, with the most emphasis given to the controlling function (11:346-347).

Planning includes the task of establishing goals and developing an outline for meeting the goals. One example of a pharmacy management goal is, "Have the proper material on hand when needed." A corresponding example of a plan for accomplishing the goal is, "Limit out-of-stock situations to no more than 5% of total requests."

Once goals have been established, the manager must organize resources available for implementing the plan. The organization process includes deciding on the best method of grouping activities and resources. Tasks, such as inventory ordering and review of on-hand stock levels, are identified. Then, the responsibility for accomplishing

each task is assigned to a specific person. Next, the available resources (personnel, supplies or equipment) are allocated for each task, so that implementation may begin (11:348).

The directing function of inventory control is a continual, ongoing activity that involves obtaining optimal performance from the available resources. The inventory manager must not only direct staff members, but must also keep abreast of the current status of all inventory management subsystems such as data processing, accounts payable, and drug-source supply problems (11:348-349).

The controlling function consists of regulation and verification of inventory system activities. One useful indicator for controlling inventory levels is the percentage of unfillable requests. Controlling inventory costs can be facilitated by monitoring the efficiency of the inventory control system, that is the total system cost per unit of inventory handled. Controlling product prices can be achieved by comparing prices paid with prices paid for the same products by similar hospitals. Additionally, invoice audit and verification of accounts payable should be accomplished. Minimizing the number of special purchases made outside of long-term contracts can further help to control product prices. Two methods for controlling inventory investment are monitoring the value of inventory level and monitoring inventory turnover rate.

Control charts are applicable to several of the inventory control mechanisms described. Daniels lists ten examples of control mechanisms for achieving materials management goals:

1. Monitor number of orders that are not completely filled by vendors.

2. Monitor percentage of requests for which pharmacy stock is depleted.

3. Monitor number of orders or line items received or dispensed.

4. Monitor total costs of inventory.

5. Monitor area productivity.

6. Monitor prices paid per product unit.

7. Audit invoices and monitor accounts payable process.

8. Monitor the number and value of noncontract orders placed versus total orders.

9. Monitor inventory value.

10. Monitor inventory turnover rate.

The application of the four management functions is a continuous cycle that involves an overlapping or intersecting of the functions, thus requiring constant integration by the inventory manager (11:346-351).

Thomas F. Hughes examined quantitative decision-making inventory control processes in the hospital pharmacy setting. Hughes details several mathematical inventory decision models developed around Economic Order Quantity and Total Cost Theory, but explains that shortage costs used in the models understate the cost of stockouts when

managing life-sustaining drugs. Shortage cost is the cost of running out of an item. This includes the costs associated with lost revenue, lost good will, overtime, special efforts to obtain an item, and special medical efforts caused by interrupted therapy. In some instances, the cost savings resulting from lower inventory levels outweigh the shortage costs resulting from occasional stock outages. However, when managing inventories of life-sustaining, critical care drugs, the inventory manager finds increased morbidity and mortality associated with outages make the shortage cost clearly unacceptable. Nevertheless, Hughes recommends that the inventory decision models be examined by pharmacy managers and applied to the appropriate, noncritical items. He further espouses the use of microcomputers and spreadsheet software to implement the complex models that are too complicated for manual caiculations (20:2078-2085).

Quantitative techniques are further explored by Michael W. Noel. According to Noel, improving control of inventory expense is one of the few quantifiable ways a pharmacy manager can reduce operating costs without reducing personnel or quality of service. Proper management of the pharmacy inventory affects the financial operation of the entire hospital. He suggests using the ABC classification of inventory, described in previous articles, and an economic order value (EOV) concept based

on economic order quantity theory. Further, Noel advocates the use of inventory turnover rates as an indicator of inventory management effectiveness (30:2379).

EOV is a scientific means for determining the optimum size of orders. EOV is based on the economic order quantity concept. As the number of orders placed per year is reduced and the amount ordered each time is increased, labor and paperwork are saved. However, as the amount ordered each time is increased, the inventory investment will increase to a point at which carrying costs exceed savings in ordering costs. EOV indicates where the total costs are lowest and how large an order to place in dollars (30:2381-2383). The formula used for computing EOV is similar to the EOQ formula. The difference is that EOV states the size of the order in terms of cost rather than order quantity.

Noel states that one of the principal indicators of effectiveness is the ratio of annual purchases to average inventory, or inventory turnover. Although it is not possible to state an ideal turnover rate for every hospital, he proposes rating inventory managers' effectiveness in terms of inventory turnover. Acceptable inventory turnover rates may be developed by performing comparisons to similar hospitals or by using the statistics published by Eli Lilly and Company in the Lilly Hospital Pharmacy Survey (30:2379).

James C. McAllister, III, also advocates ABC analysis and Economic Order Quantities. He further supports active pharmacist interaction with vendors. McAllister states that hospital pharmacists and vendor representatives should strive for a cooperative relationship by fostering ongoing dialogue, to the extent that their responsibilities and ethics allow (28:1370-1373).

According to McAllister, pharmacists should continue to demand from vendors a guaranteed fixed price on pharmaceutical agents for a predetermined contract period. Such pricing facilitates the pharmacist's budget forecasting. In order to attain fixed price contracts, however, hospital purchasing personnel must be prepared to negotiate ethically with vendors. For example, firm contract prices cannot be expected if product use estimates are unreliable. Another unethical practice is that of encouraging additional price reductions after a formal bid has been received. This is accomplished by contacting a high bidder, identifying the lowest bid price, and requesting a lower price from the losing vendor. Such unethical practices achieve only short-term gains and damage the pharmacist's credibility.

He concludes by emphasizing the importance of pharmacist participation in sound inventory management practices. Purchasing and inventory control is perceived by many pharmacists as a mundane and unrewarding

responsibility that deserves little attention. On the contrary, the acquisition and distribution of pharmaceuticals in health-care institutions require good management practices which provide opportunities for the pharmacy to contribute to fiscally sound hospital care (28:1370-1373).

Ethical practices in bidding for a pharmacy distributor is discussed by Jim Summers. Summers describes a case involving a group purchasing organization that solicited bids from pharmacy wholesalers for a committed volume of items. The purchasing group was essentially divided into two factions: those who favored competitve bidding, and those who favored a particular supplier. Service provided by the favored supplier was superb, but the possibility existed that other vendors might provide substantial cost savings. Additionally, the favored vendor was a long-time supporter, financial and otherwise, of other pharmaceutical organizations to which the purchasing group members belonged.

The competitive bidding process was conducted as planned, but the favored supplier was not the lowest bidder. The pharmacists who preferred keeping the favored vendor succeeded in convincing the purchasing group to reject the low bidder and reaccomplish the bidding process. After the second bidding process was completed, the favored supplier was the low bidder, and the purchasing group

emerged with an exceedingly favorable contract (43:64-65). As pointed out by McAllister, an unethical practice such as this ultimately damages the pharmacist's reputation, while achieving only short-term benefits (28:1372).

Communications and documentation in the University of Chicago Medical Center (UCMC) are discussed by Rodney K. Chin. He suggests that documenting inventory management problems aids in keeping all pharmacy staff members informed of current problems, and provides examples of documentation used by the UCMC department of pharmaceutical services (7:2363-2366).

The UCMC weekly drug supply problems report is used to communicate storeroom problems to other pharmacy areas. The report lists each problem item, the reason for the problem, the amount available in current inventory, the estimated date of availability, and any substitutable items. The report not only assists the pharmacist in managing the drug supply problem, but also provides a means for documenting poor vendor performance.

The weekly borrow and loan report accounts for all borrow and loan transactions and helps determine proper reorder quantities of drug products borrowed from other facilities (7:2365).

The UCMC's annual inventory assessment and turnover reports help the pharmacist determine the amount of money invested in drug inventory and the overall movement of

inventory. This study suggests that the optimal inventory turnover rate is six to twelve times annually (7:2365). However, twelve turns per year means an average of thirty days' supply of stock is kept on hand. A turnover rate of twenty to eighty times annually is a more desirable goal. A lower rate may indicate that the pharmacy has too much money invested in excessive or unused inventory. A higher rate may indicate an unnecessarily low inventory resulting in frequent stock outages (7:2365). The reliability and timeliness of suppliers is critical to the success of any inventory control strategy.

The nonformulary drug-use report described by Chin assists the pharmacist in assessing the impact of nonformulary drugs on the department. This quarterly report includes total use, cost, and area from which the drug product was dispensed.

Since the UCMC reports were developed in 1981, the pharmacy inventory turnover rate has increased from approximately six to nine times a year. Accountability for drug items has improved and a more orderly operation of the purchasing area has resulted (7:2363-2366).

Richard T. Smolarek, and others, describe pharmacy inventory management at the Detroit Receiving Hospital and University Health Center (DRHUHC) in Detroit, Michigan. DRHUHC is a 340-bed, adult trauma and ambulatory care center (42:59-65).

DRHUHC's Department of Pharmacy Services is solely responsible for the procurement and inventory management of pharmaceuticals. The pharmacy participates in a nationwide purchasing group representing over 100,000 hospital beds, but purchases approximately 80% of its items from a prime vendor wholesaler through a regional contract. These two strategies enabled the department to reduce its inventory by more than $250,000, or 57%, from 1985 to 1987 (42:63).

In 1985, the pharmacy identified the need to track inventory changes on a month-to month basis, and to be able to predict inventory levels. To maintain a constant inventory balance, a mathematical model for predicting inventory balances was developed, based on the principle that dollar value of purchases should be equivalent to the dollar value of inventory issued (42:64).

All inventory purchased is received and stored in the pharmacy's central storeroom. From there, it is issued to decentralized (satellite) units. A periodic automatic resupply (PAR) system is used to reorder inventory based on recent use and predetermined stock levels. Shelves are labeled with minimum and maximum shelf levels, suggested reorder quantities, and item numbers. Bar codes are used in conjunction with the wholesaler's electronic order device for about 60% of the shelf labels.

Each month, the central storeroom prepares an activity report that includes an inventory and purchasing analysis.

Net cost of issues is subtracted from net cost of purchases to arrive at the net change in inventory. An IBM microcomputer and software are used to generate the report. The report has been useful in monitoring the department's purchasing and inventory performance. Large fluctuations in inventory are easily identified for closer analysis. The report can be generated either manually or with computer support, but in either case accurate documentation of purchase orders and issues is crucial (42:59-65).

Automation in the Pharmacy

Stephen Hammer, outlines three major issues to be considered in automating or replacing existing automated systems in the pharmacy. First, he discusses stand-alone versus integrated systems. A stand-alone system can prove more functional for the pharmacy's internal operations, because systems which are integrated with the overall hospital information system sometimes lack depth. Additionally, substantial personnel resources are required in both the pharmacy and the hospital's information systems department, if full functionality and integration are to be achieved. On the other hand, an integrated system can satisfy the pharmacy's need to interface with other departments such as admissions, billing, and order entry. An integrated system can also screen for drug-to-food interactions, drug-to-lab interactions, and drug-to-

diagnosis indicators. Such screenings are beyond the capabilities of some stand-alone systems (17:71-72).

Next, Hammer points out that quality versus cost is a concern throughout the health care system. Overall cost to the hospital is less with an integrated pharmacy system on the existing mainframe computer. Pharmacy software systems compatible with mainframe operations are available for purchase. Significant expenditures for additional departmental hardware are avoided, as are the costs of interfacing a new system with the existing mainframe.

The third issue Hammer considers is the overall business direction of the hospital. Hospitals are diversifying into many other areas of business, such as outpatient clinics, to maintain their revenue base and compete within their industry. The pharmacy system selected must satisfy both inpatient and outpatient needs, as well as provide workload measurement and inventory control information needed for sound business decisions. Hammer concludes that the integrated system provides hospitals with the best chance to compete effectively, and that vendors should offer software systems capable of operating on the hospital's central computer while providing significant departmental functionality (17:71-72).

Nina E. Shehan (38:17-18) supports nothing less than full automation of the pharmacy. She describes the benefits of full automation in terms of improved workflow,

communications benefits, financial andvantages, and reporting benefits. Within a manual pharmacy system, the pharmacist functions as a clerk-typist, and nursing personnel are burdened with the task of keeping voluminous records. The professional skills of both these types of hospital staff members are underutilized. With automated workflow, orders are communicated instantaneously, and the patient's medication profile is automatically updated. The system checks for interactions and prints a label with all necessary patient information. When the drug is received at the nurses' station, the nurse can check it against a computer-generated patient care plan, thus reducing the potential for error. Once administered, the drug can be recorded on both the patient chart and the medication administration record, charges can be posted, and the pharmacy inventory can be updated, all in one computerized step, rather than a series of manual tasks. Pharmacy personnel can maintain better control over drug inventories with an on-line system. Resupply orders can be generated as necessary, and remote departments can check stock levels in the main pharmacy when their own supplies are low.

Communications can improve within the pharmacy and among other sections, using an automated system. For example, the information system can notify the dietary department that a patient is scheduled for a fasting glucose test, and, therefore, should not receive a meal

tray. If the pharmacy is also notified of the patient's fast, the pharmacist will know not to issue the patient any cough syrups containing sugar. The pharmacy can also be notified through the system of any scheduled surgery patients who should receive no medications.

The on-line inventory maintained by an automated pharmacy system offers financial benefits in addition to efficiency and convenience. The pharmacy can streamline its inventory by maintaining only minimal stocks of seasonal items such as snake or spider antivenins, which have a short shelf life.

Reporting capabilities of an automated system can contribute to effective pharmacy management. Pharmacy staff can use the system to track drug usage and charge it to various departments, thereby helping to pinpoint problem areas of cost recovery. With patient data, diagnosis codes, and drug product information at his disposal, the pharmacist may be able to suggest alternate, less costly drug therapy for the patient.

According to Shehan, an automated pharmacy management system allows pharmacists to more fully utilize their training and to be a total patient care professional (38:17-18).

Lt Col Jonathan A. Buth, and others, discuss administrative applications of microcomputers in Air Force pharmacies. Applications of commercially available

spreadsheet, programming, and database management software to specific Air Force pharmacy tasks are outlined. The three types of software used were the financial spreadsheet, Multiplan (Copyright Microsoft Corporation), a data base management program, dBASE II (Copyright Ashton-Tate Inc.), and Microsoft (TM) (Microsoft Corporation) BASIC (3:65-69).

The spreadsheet software was used in preparing the hospital pharmacy's operating budget submission. The software was used to review past fiscal year expenditures, project expenditures for the remaining fiscal year, then apply inflation and workload adjustments for the next fiscal year's budget request. The spreadsheet software was also used to monitor the pharmacy budget. Cost per workload unit was computed and compared to the mean in an effort to determine whether high expenditures were justified in terms of workload (3:65-66).

The data base management software was used in the management of authorized drug lists and ward and clinic reorder forms. The manual creation and revision process for authorized drug lists for each individual drug storage center was a tedious and difficult task. Each dBASEII record created included the drug, strength, unit, type, and quantity at each location. After the process had been automated, both a master list and a list by storage center could be easily generated each time a change is made.

A dBASEII drug reorder form was developed to generate and monitor clinical orders. Quantities issued were then totaled and use to generate historical usage information needed to explain significant deviations in expenditure patterns (3:67).

BASIC software was used to develop an interactive program that provides clinicians with a pharmacokinetic model for aminoglycoside dosage. The clinician inputs patient specific parameters and laboratory values, and the program outputs a drug consult for inclusion in the medical record. BASIC was also used to create a program which aids nutritional support personnel in prescribing total parenteral nutrition fluids, compounding nutritional products, and documenting therapy in the medical record. The clinician inputs patient specific variables, and the program suggests daily protein, caloric, and electrolytic requirements (3:65-69).

Issues relating to bar coding of inventory items are presented by Edward G. Nold and Theodore C. Williams. Since personnel costs are the largest expense in hospitals, they are the focal point for cost reductions. One method for reducing personnel costs is through the implementation of bar code technology. Bar coded items may be used in almost every hospital department to input information directly from an item into a computer system by scanning bar coded labels. Bar codes are currently being used to

code such items as blood containers, medical records, exchange carts from materials management, and patient wrist bands. Bar codes are also being added to the packaging of prescription drug products. Bar codes will make possible the rapid entry of data, such as stock number, quantity, and expiration date, into an automated database, and with a high degree of accuracy. Noland and Williams list fourteen potential areas for the application of bar codes in the hospital pharmacy:

1. Outpatient Pharmacy
2. Inpatient Dispensing and Inventory Adjustments
3. Billing Data Entry
4. Labels for Pharmacy-Prepared Mixtures
5. Prepackaging Records
6. Drug Disposal Records
7. Drug Expiration Data Control
8. Drug Recalls
9. Inventory Control within an Area or Department
10. Narcotic Control
11. Equipment Distributed from the Pharmacy to Other Departments
12. Drug Ordering and Inventory Control
13. Access to Restricted Areas
14. Control of Prescription Forms

One of the more crucial issues facing pharmacies who use bar coding is the medical-legal implications of a poor

scan resulting in patient harm. Although the likelihood of an erroneous scan is remote, the presence of the bar code does not relieve the nurse or the pharmacist from verifying the accuracy of drugs, blood, or other products administered to the patient. However, bar codes have been used for years in blood banks for matching blood to recipients without any reported problems.

Standardization of bar coding efforts within the health care industry is accomplished through the Health Industry Bar Code Council (HIBCC). The HIBCC develops and publishes standards for implementing bar codes in health care, provides labeler identification codes to manufacturers, distributers, and providers, and disseminates information on bar codes to manufacturers, distributors, bar-code software and hardware manufacturers, and health-care providers (31:2722-2732).

Joseph N. Gallina reports on a relational data base for pharmacy management implemented at the University of Maryland Medical System Hospital. The software package used is called Paradox. It is available from computer stores, and requires an IBM-compatible microcomputer with at least 640K of random access memory. The ability to link seemingly unrelated information from several files qualifies a data base as relational. Paradox was selected over other relational data base products because it seemed powerful, yet easy to learn.

At the time Paradox software was acquired, no one in the pharmacy department was a proficient data base programmer. Pharmacy staff learned to use the new software in a very short time and applied it to many previously time consuming management problems. Some of the software's inventory management applications include establishing a data base of items in stock, creating bin labels and shelf labels for dispensing and storage areas, creating catalogs of items available from the stockroom, generating requests for shipment and receiving reports, maintaining perpetual inventory tracking, generating expiration date tracking reports, generating reports of drug utilization by drug, therapeutic class, supplier, or user, creating and maintaining the hospital formulary, creating request-for-quote documents for procurement, and analyzing bids.

Other applications being developed include antimicrobial use data analysis, investigational drug use tracking, personnel records, publication indexing, drug information, clinical services tabulation, and work load statistics.

Data bases used by Paradox are maintained in table format. Each row is a record and each column is a field. The program uses artificial intelligence technology to guide the user through forms that appear as empty shells of the tables they represent. The user can create, view, modify, edit, enter data into, restructure, copy, or search

tables, all by following on-screen instructions. The on-line help system and well organized manual are major advantages of Paradox (15:7-15).

Fred M. Cox and Thomas E. Steed discuss the implementation of a microcomputer pharmacy management and support system at the Walton County Hospital (WCH) in Monroe, Georgia. WCH is a 100-bed, acute care facility. Pharmacy services are provided 80 hours per week, with an average staffing of 2.5 pharmacists and 2.8 technicians. Small hospitals, such as WCH, often find that a centrally based, hospital-wide computer is not financially feasible. After considering other available options, a microcomputer-based system was chosen.

The IBM-compatible hardware and Hospital Pharmacy Manager (Copyright Athens Microcomputer Center) software satisfied all system selection criteria: 1) consolidation of the labor-intensive activities into a single system; 2) simple, fast data entry; 3) compliance with state and Joint Commission on Accreditation of Hospitals standards and regulations regarding drug interaction screening; 4) true multi-user capability to allow simultaneous program use from all terminals; 5) mainframe interfacing capability for transfer of billing data; 6) ability to compile and print out reports; 7) compactness; 8) quiet, fast printers; 9) multi-operation use; 10) low cost; 11) vendor stability, commitment to support, willingness to consider and

implement suggestions for improvement, and willingness to expand the program upon request.

Hardware and software were delivered within a week of the contractual agreement, and installation was accomplished while the patient load was low. Total cost of the system and installation was $13,000.

The system's menu-driven functions include admissions and discharges, drug order entry, drug allergies and interactions screening, refill issues to medicine carts, reports, system security (passwords), and data backup. The system is also used for word processing, and plans are being made for future expansion of the system's capabilities. One of the system's major benefits has been the freeing of pharmacists from labor-intensive activities without hiring additional support staff (9:1119-1164).

Guiding the computer-shy hospital manager through various choices concerning personal computer technology is the thrust of James A. Lyon's article. Lyon discusses available computer programs that are easy to learn and can help pharmacists more efficiently manage time and resources. He recommends that the pharmacist purchase a computer and begin learning to use the system, rather than attempting to become computer literate by attending computer education courses.

Lyon recommends the purchase of an IBM-compatible system because the amount of available business software

far exceeds any of the other choices, and it is not likely to become obsolete within the next five years. He suggests the Tandy 1000 SX computer because it is 100% IBM-PC compatible, it is priced reasonably, and there are over 7,000 Radio Shack/Tandy stores that can provide service. The computer comes with a DeskMate software program that can help the pharmacisit achieve increased productivity (27:1147).

DeskMate software is easy to use and can be mastered in two weeks. It consists of a set of application programs aimed at replacing the manager's calendar, notepad, rolodex, and calculator. DeskMate includes telecommunications capability that provides access to national pharmacy information databases. The software has text editing capability, although it does not include the features of a dedicated word processing program. Also included is the Worksheet program for limited spreadsheet applications, the Filer program for limited information retrieval, and the Mail program for storing incoming messages. The user can exit DeskMate to run other programs as desired then return to the point of exit. Although today DeskMate is far from the most powerful set of programs available, it does provide an early example of how the new computer user could become acquainted with a variety of basic programs with the capability of interfacing with more sophisticated software (27:1146-1149).

Pharmacy Design

Pharmacist participation in the planning stages of pharmacy construction is described in the article by Bruce G. Kay and others. Joint pharmacist and architect planning efforts for the construction of a new 3,250-square foot pharmacy at an 870-bed institution are recounted. The planning process began with a literature review, followed by an overview of available space. The location of patient elevators and the receiving dock were key factors that shaped the initial floor plan. Supplies would be transported to the pharmacy through the door closest to the hospital's loading dock. For receiving, processing, and dispensing, the supplies would follow a semicircular path and would leave the pharmacy through the door closest to the elevators. The pharmacy's administrative suite would occupy a central core area immediately off the main access corridor.

Both fixed and mobile shelving were selected for the pharmacy's inventory storage areas. The mobile shelving system expanded storage capacity by more than 60%, compared with standard aisle fixed shelving.

The inpatient and outpatient drug distribution station was constructed with flexible fixtures. The freestanding, fixtures can be rearranged if workflow changes dictate.

Utility requirements, unique to pharmacy operation, were incorporated into the design. Additional air

conditioning requirements were identified to offset the heat generated by laminar-airflow hoods, refrigerators, and the central processing unit. Emergency power outlets were identified and the location of panic button security alarms were carefully selected.

After the new pharmacy began operation, managers found that the design minimized the amount of walking required and provided an efficient working atmosphere. The participation by a pharmacist in the planning, design, and construction of a hospital pharmacy resulted in a facility that suited the unique needs of the institution, yet was versatile enough to allow for changing demands or increasing workloads (22:339-343).

Pharmacy Operations in a Field Hospital

Dasher describes pharmacy operations in the 47th Field Hospital while deployed to Honduras during the period of February to May 1984. Obtaining medical supplies during deployment proved to be a challenge, due to long order lead times. Management of inventory levels was crucial.

The mission of the field hospital was to support United States troops in the immediate area, to provide support for United States military personnel in the Central American area, and to augment the local civilian health-care system. A large amount of medical equipment and supplies were left by the medical unit that the 47th Field Hospital replaced, thus no actual set-up was required.

Pharmacy staffing consisted of one officer and four enlisted technicians. Pharmacy personnel not only performed their specialty duties, but were also required to perform guard duty, kitchen duty, field sanitation tasks, and officer of the day duties. The noncommissioned officer in charge of the pharmacy slept in the pharmacy tent to provide added security.

Pharmacy supplies were ordered through the 47th Field Hospital supply section, who, in turn, processed the orders through Panama. Pipeline times for routine orders were as long as 28 days.

The pharmacy began operations in a general-purpose, medium tent, but was later moved to a large tent with more space for inventory storage and more conveniently located near the emergency medical treatment and ward tents.

Pharmacy workload during the two-month deployment included 24,038 prescriptions. In addition to outpatient prescriptions, some nonprescription items were available on a handout basis. Items such as sunscreen and chapstick were readily provided.

Pharmacy services played an important role in the success of the mission. The physicians in a were very receptive to the pharmacist's suggestions concerning dosage regimens and treatments. In addition to gaining military experience, personnel were also able to aid the civilian population of an impoverished country (12:576-580).

Pharmacy Personnel Issues

Rose suggests closer interaction between the pharmacist and patient as a means of increasing job satisfaction and motivation within the pharmacy (35:31-37). In a hospital work setting, it is easy for some employees to lose sight of the ultimate customer--the patient. Rose cites a study by Williamson and Kabat that found hospital pharmacists are largely dissatisfied with their profession. Dissatisfaction was attributable to the fact that while being encouraged to expand their professional activities, pharmacists are denied such expansion by their working environment. Thus, a conflict exists between the work environment and the desire for professional growth.

Programs that place the pharmacist in patient care areas have been successful because of the improvement in care rendered. Such programs have also been associated with higher levels of job satisfaction for the pharmacist. By interacting more closely with the patient, the pharmacist develops a better appreciation of the task functions for which he or she is responsible. Studies in the area of job satisfaction for hospital pharmacists indicate that clinical pharmacists, whose duties include high patient interaction, have the highest score, while pharmacists assigned to the inpatient hospital pharmacy, with little or no patient interaction, score the lowest (35:36).

In an effort to apply this job satisfaction theory, and reduce medication errors, a decentralized cartcheck system was developed. The system involved the pharmacist and pharmacy technician travelling directly to the nursing units at scheduled times with a supply of medications intended to cover a 24-hour period. The response was positive as pharmacy and nursing personnel came to accept each other as members of a patient care team. Pharmacy technicians were given further opportunity to participate in direct patient care, when they were assigned to assist the pharmacist on the emergency response team. By witnessing first hand the life-sustaining effects of their medications, the technicians acquired a strong appreciation of task significance and feedback. A new attentiveness to procedures involving restocking of emergency medical carts after use was fostered (35:31-37).

Pharmacy Cost Management

Jeffrey offers an editorial on the attempt to continuously reduce costs while improving quality (21:6). Jeffrey states that program development in hospitals formerly evolved around "better patient care". If a program was good for patient care, then it was easy to get approved and implemented. Next was the era of "cost containment". Regardless of how valid a program was, managers were expected to contain (which translated to "cut") costs. One measure of progress was keeping the

expense budget at the previous year's level. The current era, according to Jeffrey, is the age of quality and excellence. Hospital pharmacies are no exception. Pharmacies, too, are challenged to do things well at a lower cost. He cites several factors impacting pharmacy operations:

1. There is both a current and projected shortage of pharmacists.

2. Pharmacists now beginning practice are innovative and creative. They reject old methods and prefer to work in clinical services.

3. Pharmacy managers have been compelled to work smarter and harder to meet standards of performance.

4. Information is being generated too quickly to manage. The receipt of some information by patients creates a desire for more.

5. An effort is underway in the pharmacy community to substantiate achievements by developing standard methods for measuring outcome.

These factors mean that pharmacy personnel must improve their skills in handling vast amounts of information. They need to be more creative in using their skills. The effort to continue improving quality while reducing costs must continue, but the point at which quality and economy deteriorate must be identified (21:6).

Pharmacy Quality Assurance

Demers and Moore outline the ideal characteristics of a pharmacy quality assurance system (14:45-54). A crucial

part of the pharmacist's mission is assuring that medications are properly administered to the patients. To accomplish their mission, pharmacy departments should actively participate in developing programs that assure medications are safely and effectively administered to patients.

Professional standards of practice, accreditation standards, and medical/legal precedents suggest that pharmacists should participate in medication error reporting systems. A medication error is any administration of a drug that deviates from the original physician's order as defined in hospital policy and procedures. Because of their unique knowledge of drugs, pharmacists can assist risk managers in determining patient outcomes resulting from medication errors.

Pharmacy and nursing management should collaborate in establishing goals for a quality assurance system. Once goals have been established, several ideal characteristics should be used to structure the quality assurance program. The program should be consistent, informative, ongoing, flexible, inexpensive, quantitative, qualitative, and legally sound (14:49-50).

Demers and Moore describe the quality assurance procedures used in reporting medication errors at the Ohio State University Hospitals. Data from the medication incidents are then translated into usable trends compiled

in a management document. When any hospital staff member discovers a medication incident, a professional staff member from the department responsible for the error is contacted. That staff member, usually a nurse or a pharmacist, is responsible for gathering sufficient information and documenting it on a "Report of Unusual Incident" form. The staff member also contacts the appropriate physician for instructions for following the patient. The physician then signs the incident report and comments about changes in therapy or patient condition. The form is then sent to the assistant director of nursing or an assistant director of pharmacy for collection for future use. The reports are reviewed monthly, and one copy of each report is sent to the hospital risk manager. Pertinent information is extracted and loaded into a database program on a microcomputer for trend analysis. Incident reports are reviewed monthly at a meeting of the hospital's quality assurance coordinator, assistant director for nursing quality assurance, and assistant director of pharmacy (14:45-54).

III. Methodology

Overview

The general method of research applied in this study was the case analysis. First a comprehensive literature review was accomplished, followed by an experience survey of key medical center personnel and members of staff agencies external to the medical center. Management policies affecting pharmacy inventory operations are identified followed by a description of pharmacy management inventroy management practices.

Literature Search

An automated literature search was performed to identify background articles on hospital pharmacy inventory management and hospital pharmacy operations in general. The search returned a list of 120 articles, 29 of which are relevant to this study. A review of literature is presented in Chapter II.

Experience Survey

Medical materiel management has rapidly evolved over the past three years. Computer support has evolved from a punched-card-based, batch processing system supported by multiuser, mainframe hardware, to the current on-line system supported by a dedicated minicomputer. Additionally, advances in other areas affecting pharmacy operations, such as medical quality assurance and base

contracting, have outpaced literature publication. In order to gain insight into such recent developments, an experience survey was conducted.

Key members of the medical center staff were interviewed to obtain the benefit of their experience in areas related to pharmacy management. The chief of pharmacy services, the noncommissioned officer in charge of the pharmacy, and the noncommissioned officer in charge of pharmacy supply were interviewed to obtain their assessment of the current situation. Other medical center staff members interviewed include medical logistics personnel and resource management personnel.

The Air Force Medical Logistics Office at Fort Detrick, Maryland, was contacted by telephone to obtain current guidance on innovative medical procurement practices. The Tri-Service Logistics Development Group, also at Fort Detrick, was contacted regarding pharmacy applications of the Central Processing and Distribution (CP&D) system. The Air Force Office of Medical Support at Brooks AFB, Texas, was contacted for information on the Tri-Service Micro Pharmacy System (TMPS). Headquarters, Standard Systems Center, Medical Logistics Division, at Gunter Air Force Station, Alabama, will be contacted for input regarding current applications of the Medical Logistics (MEDLOG) computer system.

Identification of Management Policies

Management polices within the medical center flow from several sources. Air Force regulations, medical center regulations, policy letters, and pharmacy operating instructions all provide guidance. Additionally, the pharmacy, along with other hospital departments, is tasked to comply with standards published by the Joint Commission on the Accreditation of Hospitals.

Sources of management policy relevant to inventory management were reviewed. The pharmacy self-inspection checklist was used as a guide for identifying existing policies.

Inventory Management Procedures

The procedures for identifying inventory requirements were examined. Inventory ordering, storage, and delivery practices were documented. Particular attention was given to the interface between the pharmacy and medical materiel. Pharmacy ordering practices were contrasted to other sections' practices. Further, the interfaces between medical materiel and its various sources of supply are outlined.

External management practices contributing to the quality of outpatient pharmacy service were examined. Of key concern was the inventory management system supporting the pharmacy. The chain of supply was studied from the commercial origin of the supplies, through the various

government and procurement pipelines to the pharmacy, and ultimately, to the patient. When options were available to managers at any point within the supply chain, an attempt was made to discern why a particular method of accomplishing the work was preferred over other alternatives.

An attempt was made to identify management practices which contribute to the quality of outpatient pharmacy service at Wright-Patterson Air Force Base. Those factors were then compared to similar practices at the Keesler Air Force Base, Mississippi, pharmacy, a comparably sized operation.

ABC Inventory Analysis

An ABC analysis of issue history was performed to identify high dollar volume inventory items which may merit closer management attention. An ABC analysis is based on the assumption that relatively few inventory items account for most of the investment in inventory. Annual usage of pharmacy supplies was ranked according to dollar volume. The ranked items were divided into three groups: Group A includes approximately the top twenty percent of the items, Group B includes the next thirty percent, and Group C contains the lower fifty percent of line items (6:605-606). Annual consumption data was extracted, by line item, from the medical materiel Using Activity Stock Status Report.

Chapter IV. Discussion of Findings

Management Policies

Pharmacy management use a consolidated self-inspection checklist to ensure compliance with governing policies. The checklist reflects policy guidance from a variety of sources including Air Force regulations, policy letters, the Joint Commission on Accreditation of Hospitals, and the Health Services Management Inspection checklist, published by the Air Force Inspection and Safety Center, Directorate of Medical Inspection, Norton Air Force Base, California. Checklist items related to inventory management include:

1. Storage of medications located outside the pharmacy
2. Supply inventory and control
3. Controlled drug accountability
4. Security of bulk stock storage areas
5. Drug recall procedures (Checklist:1-7).

The checklist item which addresses supply inventory and control asks whether locally written and procedures includes guidance on supply and inventory control. The pharmacy supply custodian is currently writing an operating instruction to be used in training other pharmacy personnel in locally established inventory management procedures (4). Other checklist items relate only indirectly to this case study. Although important to other aspects of pharmacy management, they are not given detailed treatment here.

Inventory Management Procedures

Pharmacy inventory requirements include both drug and non-drug items. Requirements for drug items originate as health care providers determine that a drug needs to be stocked. The health care providers' requests for new drug items are sent to the medical center's pharmacy and therapeutics committee for consideration. Once approved by the committee, new drugs may be added to the medical center formulary and ordered through medical materiel supply. Emergency procedures exist for tentatively approving new drug requirements which must be ordered between committee meetings. Pharmacy management determines requirements for non-drug items, both medical and non-medical (14). Items ordered fall into one of two categories: either standard items or local purchase. Standard items are normally stocked in a Defense Logistics Agency supply depot, while local purchase items must be procured from commercial sources.

Each request for local purchase requires approval by the local purchase approval authority, and is reviewed by the medical materiel local purchase section to make sure no equivalent standard item exists. Research publications, available on laser disks, are accessed through a Zenith Z-248 personal computer (40). New requests for standard items require no special approval. After an item has been approved for use, it may be added to the Using Activity

Shopping Guide for ordering convenience. The shopping guide is a MEDLOG listing, by supply account, of items which are ordered routinely. Each item the pharmacy supply custodian elects to have on the shopping guide is assigned an index number by the MEDLOG computer system. The index number provides a quick means of identifying the item to the MEDLOG system. Each time the shopping guide is produced by medical materiel supply, any new items are added to the list and index numbers are reassigned. The new shopping guide is then assigned a control number. When placing shopping guide orders, the pharmacy custodian must make sure he is ordering from the most current shopping guide.

The pharmacy supply custodian orders all supplies through the medical center's medical materiel section (4). Routine orders are accomplished weekly. Orders are prepared on Monday and taken to medical medical materiel by the pharmacy supply custodian (14). The custodian spends approximately eight hours per week preparing the supply order. The alphabetically sequenced stock on the supply room shelves is inventoried and reorder quantities are computed. Items are labeled with a stock number, unit of issue, item nomenclature, and the estimated two-week level. Although the level is an estimate computed by the pharmacy supply custodian, the MEDLOG system also computes a two-week level, based on issue history over the previous twelve

months. Ordering information is input to a micrcomputer file, sorted by stock number, and printed. Then, the shopping guide index numbers are annotated beside each line item and the listing is taken to medical materiel supply. The custodian makes frequent trips to medical materiel supply to check on problem items, and, therefore, seldom makes a special trip specifically for the purpose of dropping off an order list (4).

Formerly, stock was stored in stock number sequence on the pharmacy supply room shelves. Stock number sequencing resulted in a lower order preparation workload. The supply custodian could immediately identify shopping guide index numbers, as the order was being developed, by referring to the shopping guide list, also produced in stock number sequence. The order quantities were then immediately handscribed beside their corresponding, preprinted index numbers on a locally produced form. The form was then taken to medical materiel with no further manipulations by microcomputer. With the current, alphabetical sequencing on the shelves, order preparation time could be reduced if the shopping guide list were produced alphabetically. Identifying index numbers as the alphabetically sequenced shelves are being inventoried would require extensive searching through almost one thousand items on the stock number sequenced shopping guide (4). Although MEDLOG currently lacks the capability to produce the shopping

guide in alphabetical sequence, the system can produce the listing in location code sequence. Location codes may be locally developed and controlled by the supply custodian. Hence, to simulate alphabetical order, a numerical location code could be assigned to each item on an alphabetically sorted listing. For example, three stock items beginning with the letters "A", "B", and "C" could be assigned location codes "1", "2", and "3", respectively. When sorted by location code, the items would also appear in alphabetical sequence (16).

The primary computer system supporting the outpatient pharmacy is the Triservice Micro Pharmacy System (TMPS). Although the TMPS has inventory management capabilities, they have not been fully activated at the Wright-Patterson pharmacy because of the high cost in manhours of initiating and maintaining the system (4). Although the TMPS is useful for managing inventories of controlled drugs, the number of manual manipulations involved make it impractical for managing all of the pharmacy inventory. TMPS was originally programmed for commercial pharmacies to use in tracking their orders through a multitude of vendors (32).

Another system, Central Processing and Distribution (CP&D), already in use at the Wright-Patterson Medical Center, is being considered for expansion to include the pharmacy (4). The CP&D system makes use of bar coding technology for assisting with order entry. Additionally,

an interface between the CP&D system and MEDLOG is being developed at Headquarters, Standard Systems Center. MEDLOG (16). If implemented, the CP&D system will allow the pharmacy custodian to produce bar coded labels for each item on the supply room shelves. A battery-operated, hand-held scanner will assist the custodian in inventorying the shelves during the ordering process. The custodian will scan the label of the item being inventoried, then use the keypad on the scanning unit to enter the quantity physically counted on the shelf. After all items have been counted, the portable unit will be connected to the CP&D system. Quantities counted during inventory will be subtracted from the items' stock control levels, as loaded in the CP&D system, and requistions will be electronically passed to the MEDLOG system. However, in order for the Wright-Patterson CP&D system to be successfully expanded to include the pharmacy, the system's two disk drives must be expanded from 85 megabytes each to 190 megabytes each. The estimated cost of purchasing the two larger disk drives is $10,000 for both drives. Budget requests for the disk drives must be developed locally, as they fall below the cost threshold for equipment centrally purchased by the Triservice Logistics Development Group (45). The noncommissioned officer in charge of the medical center's CP&D section has begun the early stages of requesting that the larger disk drives be procured. Regional CP&D training

slots can be requested by sending a letter to TRILOG/IDG, Fort Detrick, Maryland, ZIP code 21701-5000 (45).

The Wright-Patterson medical materiel office is located in a separate building, approximately one mile from the main medical center building that houses the outpatient pharmacy. Medical materiel personnel input new item requisition data into the MEDLOG computer system. For routine shopping guide orders, the only information required is the index number of the item and the quantity (40).

Most custodians telephone their orders to an answering machine located in the medical materiel office. Call-in hours were established from 8:00 Friday until 12:00 noon on Tuesday to accomodate the sections who prefer to order during the weekend shift. Custodians of the major accounts, such as pharmacy, prepare written supply orders (40).

During end-of-day processing, the MEDLOG system generates requisitions in various formats, depending on the source of supply. The majority of local purchase requisitions are sent to the base contracting office, located approximately one half mile from medical materiel. MEDLOG produces floppy disks containing the requisition data required for base contracting to begin local purchase action. However, due to the incompatibility between the MEDLOG system and the Base Contracting Automated System

(BCAS), the floppy disks must be converted by the base data automation activity to a form readable by BCAS. The process of sending the disks to data automation, having them converted, and having them forwarded to base contracting requires three days (40). BCAS uses the requisition data to create an automated purchase order for the base contracting buyer. For recurring purchases with multiple sources available, BCAS rotates orders among vendors, and includes the vendor data on the automated purchase order. The purchase order is sent to the vendor, who is directed to ship the item to the medical materiel warehouse.

Floppy disks are also produced for standard item requisitions. The disks are sent to data automation, converted to Automatic Digital Network (AUTODIN) format, and transmitted electronically to the Defense Personnel Support Center (DPSC) in Philadelphia, Pennsylvania. DPSC then directs the appropriate medical supply depot to ship the items to the Wright-Patterson medical materiel warehouse. The pipeline time for depot orders is approximately thirty days (40).

Other requisitions are placed directly from the medical materiel local purchase section to the vendor under the terms of a blanket purchase agreement (BPA). A BPA is an agreement between the vendor and the government that allows specified officials to order direct from the vendor

for items appearing on the vendor's price list. A contracting official must approve the price list, both initially and each time an update is made.

Two decentralized BPAs for drug items are currently being used. Decentralized BPAs are negotiated by the Defense Logistics Agency and made available to all medical materiel managers. Items ordered are typically received within three to five days after being telephoned to the companies. Next-day delivery is available for urgent requirements. In addition to the decentralized BPAs, a local BPA is being negotiated, but is not yet in effect (40).

For emergency local purchase requisitions, medical materiel personnel first notify base contracting by phone that an emergency requisition is being sent. The medical materiel technician then enters the requisition information directly into BCAS via the remote BCAS terminal located in the medical materiel office. BCAS, in turn, generates a purchase order in the base contracting office, for the buyer's use. The majority of local purchase requisitions are processed through the base contracting office, but the medical materiel manager also has access to a $5,000 petty cash fund to use for emergencies when base contracting action is not appropriate. Approximately fifteen to twenty-five petty cash purchases are made weekly by the medical materiel office (40).

Inventory Delivery

Routine orders placed by the pharmacy on Monday are entered into the MEDLOG system on Tuesday and Wednesday. Deliveries are made to the pharmacy on Wednesday and Thursday. Routine deliveries are hauled in a semitrailer pulled by a truck tractor. The tractor-trailer rig is provided by base vehicle management, and is not permanently assigned to the medical center. Non-routine orders are delivered daily, or more often, depending upon urgency of need. Non-routine deliveries are hauled in a one and one half ton cargo truck assigned to the medical materiel office. In some instances, the pharmacy custodian picks up non-routine orders from medical materiel supply (40).

Orders received by the outpatient pharmacy are stored on shelves in a room adjacent to the outpatient pharmacy production area, as well as on the shelves in the production area itself. Items are sequenced alphabetically for ease of location by technicians and volunteers not familiar with the stock numbers.

A list of items on backorder is provide to the pharmacy each time an issue cycle is completed, and a cumulative summary is produced at the end of each month. However, the backorder listing does not reflect the current status, such as expected backorder release date, for all items. Current status is given only if the entire quantity on backorder from the source of supply to medical materiel

is computer-linked to the backorder from medical materiel to the pharmacy (4). For example, if ten bottles of aspirin were on backorder from the source of supply and the same ten bottles were on backorder to the pharmacy under a computer-linked document number, only then would the most current status appear on the backordrer report. On the other hand, if twenty bottles (ten for stock and ten for the pharmacy) were backordered to medical supply, the two backorders would normally not be linked and current status would not be provided. Knowing the current status of backorders helps the pharmacy custodian avoid unnecessary costs associated with ordering excessive quantities of high-cost, emergency-procured items. The current pharmacy supply custodian, however, is allowed to use medical materiel's MEDLOG terminal for status inquiries and for updating shopping guide data (4).

Another problem associated with backorders is their impact on the medical materiel warehouse's stock levels. One factor used in computing warehouse inventory levels is the number of issues. The longer an item is on backorder, the fewer issues are recorded. As the number of issues declines, so does the stock control level. For example, while one drug was on backorder over a six-month period, its stock contol level dropped from approximately 120 to 72, even though patient demand for the item may not have decreased (4).

Keesler AFB Pharmacy

One of the more conspicuous differences between the Keesler and Wright-Patterson pharmacies is their locations in relation to their supporting medical materiel sections. At Keesler, both the pharmacy and medical materiel are located on the basement floor of the main medical center building. The proximity of the two sections greatly facilitates their interactions. Supplies can be delivered from the medical materiel warehouse to the pharmacy on supply carts instead of by truck. The pharmacy supply custodian can visit the medical materiel section several times daily, when necessary, without losing time in transit. A close, interpersonal working relationship has developed between medical materiel and both the current and previous pharmacy supply custodians (10).

Some of Keesler's inventory ordering and delivery practices also differ from the Wright-Patterson methods. At Keesler, the pharmacy supply custodian places two routine orders weekly, instead of one. The first order is a major order and is placed on Monday. The second order, placed on Thursday, is smaller, and includes fast-moving items. The second order allows the pharmacy to recover from surges in demand not forecasted when computing the major order. The ordering schedule was mutually agreed upon by the pharmacy and medical materiel. Medical materiel might be willing to accept oders more frequently,

but the pharmacy custodian states that ordering too often, especially every day, would be impractical due to the workload created by inventorying the shelves in the supply storage room (23). A computerized perpetual inventory system would be needed to make daily ordering a practical alternative.

The Keesler pharmacy's main inventory storage area is located in a supply room adjacent to the main outpatient pharmacy. The outpatient pharmacy is divided into two production areas: a blue pharmacy and a white pharmacy. The divided operation employs two data-entry technicians and two prescription checkers. This helps prevent the bottlenecks that can occur when only one of each is used. Each production area has its own inventory storage shelves. As the stocks for any item become low in either of the production areas, pharmacy technicians restock their shelves from the main supply room. When the last of an item is taken from the main supply room's shelves, the technicians annotate the item information on an "out list" kept just inside the entrance to the main supply room. The pharmacy supply custodian uses the "out list" as a means of identifying inventory items that require immediate attention (23).

Items with recurring demand are stored on the main supply room shelves in stock number sequence. One-time orders are stored in alphabetical order, on segregated

shelves. To prepare an order, the supply custodian inventories each item and determines the quantity to be ordered. He then cross-references the stock number from the shelves to the latest shopping guide list to identify the current index number for that particular stock number. The custodian then annotates the quantity to be ordered beside the corresponding index number preprinted on a locally developed shopping guide order form (23).

The pharmacy custodian takes the order list to medical materiel for input to the MEDLOG system. A medical materiel technician normally keys in the pharmacy order, but the pharmacy custodian is also allowed to use the MEDLOG terminal for placing shopping guide orders and for running status inquiries (33). An issue list is procuced during MEDLOG end-of-day processing. The following morning, the pharmacy's order is ready to be picked from the shelves of the medical supply warehouse.

The pharmacy's order may be picked from the shelves by medical supply warehousemen, but the pharmacy custodian is often allowed to pull the order himself, if escorted by a member of the medical materiel staff. Additionally, items backordered to the pharmacy have their requisitions specially marked so that items may be easily identified and segregated upon receipt by the medical materiel warehouse. This enables the custodian to easily identify and pick up backorder realeases on a daily basis (23).

ABC Inventory Analysis

Supply issue history for the Wright-Patterson outpatient pharmacy was extracted from the Using Activity Stock Status Report, dated 17 May 1989. The report lists all items issued by Medical Materiel to the outpatient pharmacy on a recurring basis. Issue history for the twelve-month period of May 1988 through April 1989 is also included. The report identified a total of 978 items with the total dollar value of issues amounting to $4,298,961.05. Total dollar value of issues is computed using the latest price paid for items. Thus, some variation from the actual price historically paid will exist. However, use of the latest price paid may make the computations more meaningful for future inventory planning.

Issue data from the Using Activity Stock Status Report were manually input to a QUATTRO spreadsheet software program file for sorting. Items were sorted by total dollar value of issues for the twelve-month period being studied.

The items responsible for the highest dollar value of issues were identified in the A category. The 196 A items accounted for only 20% of all line items, but were responsible for 88% of the total dollar value of issues. The top ten line items, alone, accounted for $1,282,801.98, or 29.84% of the total dollar value of all issues. B items totalled 293, or 30% of total line items, and were

responsible for 10.23% of the total dollar value of issues. The remaining 489 items were categorized as C, and included 50% of all line items, but only 1.77% of the total dollar value of issues. In the C category, a total of 82 items, or 16.77% of the category, reflected no issues during the twelve-month period covered by the report.

Figure 1 shows the distribution of line items by category and Figure 2 shows the distribution by dollar value of issues.

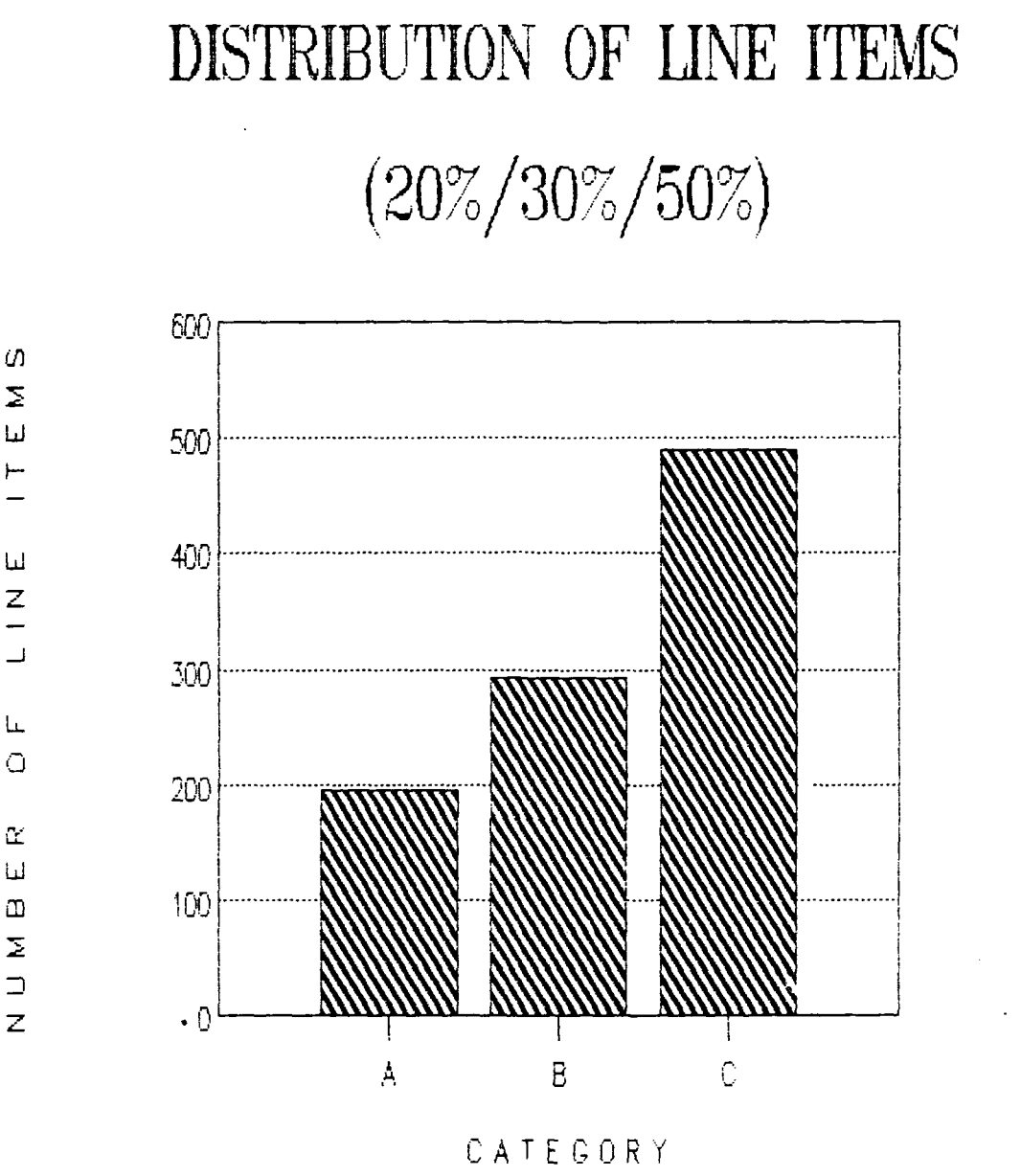

Figure 1. Distribution of ABC Inventory Categories by Number of Line Items

DISTRIBUTION BY $ VALUE OF ISSUES

(88%/10.2%/1.8%)

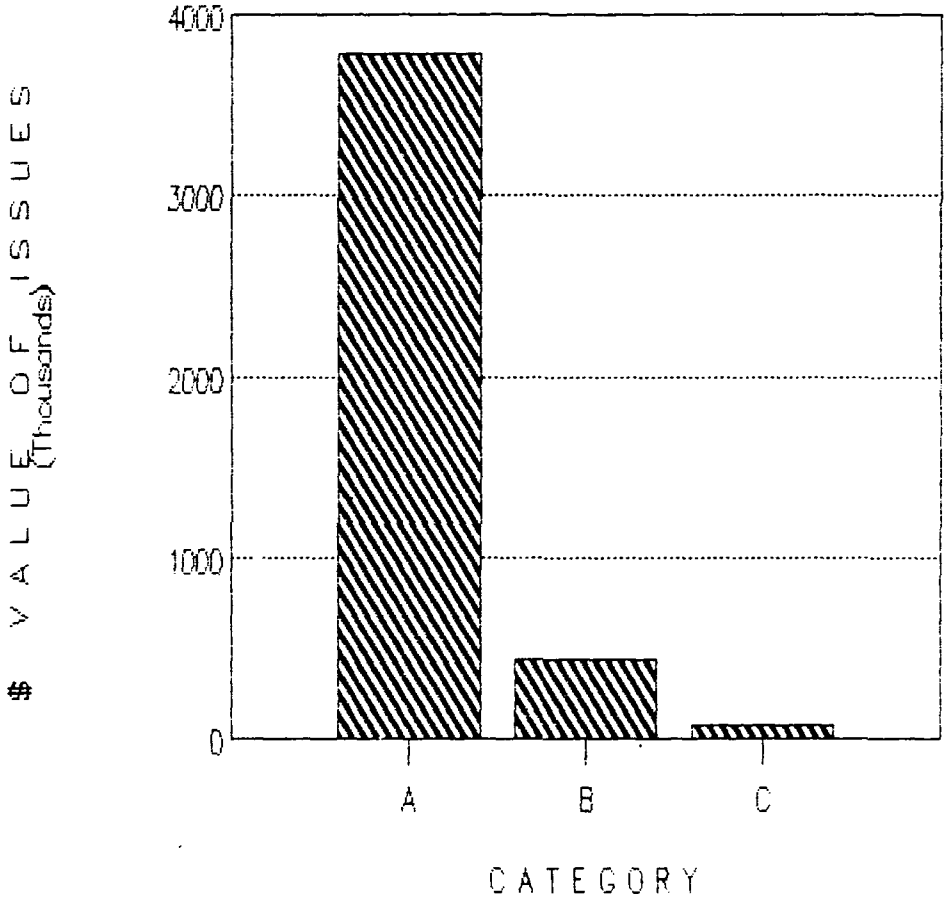

Figure 2. Distribution of ABC Inventory Categories by Dollar Value of Issues

Chapter V. Conclusions and Recommendations

Management Policies

Allowing the pharmacy custodian access to on-line inquiry menus through the MEDLOG terminals is an innovative, beneficial practice that should be officially sanctioned by the medical center commander and advertised among other USAF medical treatment facilities. This practice enables the custodian to acquire current status and become familiar with requisitions from a medical materiel technician's perspective. Ready access to current status could be useful in preparing a drug supply problems report similar to the one used by the University of Chicago Medical Center (6:2363-2366). Such a report could be used to communicate supply problems to other pharmacy areas as well as to the prescribing health care providers.

One drawback to this policy is that the custodian is not prevented access to other menus which, if misused, could adversely affect other supply operations. Until the MEDLOG system is updated with password capability to control access by users from outside medical materiel, a formal agreement should be negotiated between medical materiel management and users, such as the pharmacy custodian, who are allowed limited access to the MEDLOG terminals. The agreement could be in the form of a letter from the accountable medical supply officer nominating an individual for limited access to the MEDLOG terminals. The

nomination letter could detail specifics, such as which menus the custodian is allowed to use. The agreement could be sanctioned by the medical center commander with an indorsement authorizing the limited access and directing the custodian to comply with the specifics of the nomination letter.

Pharmacy managers have addressed the need to have supply custodians well trained in medical materiel management (36). Indeed, some pharmacy budgets at large medical treatment facilities far exceed the Medical-Dental Stock Fund budgets of materiel managers at smaller medical treatment facilities (32). At recent symposiums, pharmacy managers addressed the need to include a medical materiel technician in their manpower standards to perform the function of supply custodian (36). This is an issue for manpower officials to consider when revising manpower standards.

Inventory Management Procedures

The workload involved with a weekly reorder cycle might be leveled to more easily manageable proportions by ordering twice or three times weekly. As is the practice at the Keesler pharmacy, a second, though smaller order during the week helps prevent the shortages that occur when attempting to forecast requirements only once per week. A second or third "catch-up" order during the week could

result in smaller supply orders which could be transported in medical materiel's assigned cargo truck. The desirability of such workload leveling could be tested by implementing a semi-weekly ordering cycle on a temporary basis, then evaluating its effects on both medical materiel and the pharmacy.

Order Transmittal

Manhours required for the pharmacy's inventory ordering process might be reduced by changing the method used to order. An immediate enhancement to the ordering process would be to utilize the location code option on the Using Activity Shopping Guide. Assigning a location code to each item would not be practical because each new item added could necessitate extensive changes in location code assignment. However, the supply room shelves could be segmented into a series of location codes. For example, all items beginning with the letters "AA" could be assigned to location code "1", items beginning with "AB" could be assigned location code "2", and so forth. While a location code sequenced shopping guide produced under such a numbering scheme would not produce a list in exact alphabetical order, it might provide a convenient enough sorting to eliminate the need for microcomputer manipulation of routine orders.

If, however, the practice of using a microcomputer is continued, other available software packages could help

eliminate the need to manually write in the current MEDLOG index numbers on the microcomputer produced order lists. With spreadsheet software such as Quattro or Lotus 1-2-3, the microcomputer inventory database could be sorted in the same sequence as the current shopping guide. Then, with a few simple commands, index numbers, matching MEDLOG's, could be reassigned without having to separately enter each new number.

Another shopping guide feature that might enhance inventory management is the suggested level. Each time a Using Activity Stock Status Report is produced, the option is available to update the Using Activity Shopping Guide with a using activity stock control level. This level represents a two-week supply of each line item, as computed by MEDLOG. The two-week level provided by MEDLOG could be compared against the two-week level posted on the pharmacy supply room shelves. For example, if the shelf shows a level of 100 and MEDLOG suggests a level of 10, the possibility exists that either too much is being stocked in the pharmacy or that MEDLOG is not forecasting enough demand, and medical materiel warehouse stocks will eventually be depleted, resulting in a backorder.

A long-range solution to the labor-intensive reordering process might be an on-line link between the pharmacy's IMPS and the MEDLOG system. The pharmacy's system currently has the capability to track inventory

issues from the pharmacy to patients. An ideal enhancement would be to generate a pharmacy inventory requirements file for on-line transmission to MEDLOG. With such an on-line link to medical materiel, the pharmacy could view the status of backordered items and better plan emergency requisition quantities. Unfortunately, TMPS, as it exists would require a number of manhours to activate its inventory capabilities for all pharmacy items. Also, TMPS is an interim system already slated for replacement by the Composite Healthcare Computer System (32). The Central Processing and Distribution (CP&D) system, however, does appear to provide a desirable solution. To realize its fullest benefits as early as possible, the medical center must take aggressive acquisition action to obtain the two 190-megabyte disk drives needed to support the pharmacy. Also, a training quota should be requested for sending the pharmacy custodian to regional CP&D training.

The ordering process between medical materiel and base contracting could be reduced by three days if the MEDLOG and BCAS systems were made compatible. The feasibility of purchasing or developing emulation software capable of allowing the MEDLOG system to output requisitions on floppy disk in a format compatible with BCAS should be determined.

The problems associated with decreasing levels on backordered items could be alleviated by a software change to the MEDLOG system. Such a change could prevent

readjusting the stock control levels of any items with current backorder quantities.

Inventory Delivery

Adoption of multiple order cycles during the week would smooth the inventory delivery workload. Instead of requiring a tractor-trailer rig for one to two days per week, deliveries might be adequately accomplished using the smaller truck. Increasing the number of order cycles might prove more responsive to supported hospital sections. Changing to multiple order cycles could be tested incrementally with a few custodians at a time to determine the impact on medical materiel and overall service quality to the medical center custodians.

ABC Inventory Analysis

Pharmacy management should consider the items identified in the A category as a starting point for designating items which merit the closest inventory management controls. Added to the A category would be other, life-sustaining drugs, which warrant closer control because of their critical nature. Such critical drugs, even though they may experience low dollar value of issues, may require close control.

Pharmacy management may qualitatively select other drugs to add to or delete from the A category. For example, the Using Activity Stock Status Report lists a

history begin date for each line item. For newer items, issue history has been recorded for only a few months. While actual issues during the twelve-month period studied may suggest the items belong in the C category, pharmacy management may choose to move the items into the A category because of the expected future volume of issues. Conversely, items already in the A category may be removed because of projected deletions from the hospital formulary.

"A" items present prime candidates for frequent review of source of supply. For each line item, the Using Activity Stock Status Report lists a routing identifier (RID), which indicates the source of supply. RID codes identify items purchased through the government supply depot or through a potentially more costly local purchase. Locally purchased "A" items could be researched for lower-priced, standard items with equal specifications each time an update to the federal supply catalog is received.

ABC analysis can also be used to identify items to be deleted from stock. Items appearing in the C category, but having no issues during the period of the report, should be reviewed for possible deletion. Such items, if no longer required by the pharmacy, could be identified to medical materiel. Medical materiel could then delete the unneeded items from inventory and attempt to redistribute excess stocks, if not required for support of other customers. It is important to note that a lack of issues for a particular

drug is not a sufficient reason for not keeping it in stock. Decisions concerning what to stock should be made only after a careful review of the impact of stockouts.

The ABC analysis done for this research was labor intensive. Each of the 978 items from the Using Activity Stock Status Report was entered by hand into a microcomputer for sorting. The process required over 50,000 keystrokes. Future ABC analyses could be facilitated by programming a simple sorting routine into the MEDLOG software used to support the medical materiel section. The MEDLOG system previously produced a High Dollar Issue List showing the top one hundred items with the highest dollar value of issues to all supported supply accounts, combined. A similar listing, if made available by individual supply account, would assist not only the pharmacy, but also custodians of other large supply accounts to more easily identify items requiring closer management. Manual input of issue history from the Using Activity Stock Status Report to a microcomputer software program for sorting is extremely labor intensive, making manual analysis prohibitive.

Recommendations for Future Research

This study examined inventory management at a single pharmacy, with limited comparisons made to a second medical center pharmacy. Further research could be

broadened to quantitatively compare all United States Air Force medical center pharmacies. Indicators such as prescription waiting times, supply pipeline times for drugs. medical supply fill rates, emergency pharmacy requisition rates, pharmacy manning levels, type and magnitude of computer support, and patient satisfaction could be compared to identify significant differences among the medical centers. Facilities with significantly better indicators in any area could be studied more in-depth. A composite of all best methods could then be synthesized into a concrete guidance document for pharmacy inventory managers.

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The purpose of this case study was to examine outpatient pharmacy services at USAF Medical Center, Wright-Patterson AFB and identify ways of improving service to patients by improving inventory management. Research was also conducted at USAF Medical Center, Keesler AFB to contrast inventory management practices between the two facilities.

A review of the literature identified a variety of pharmacy management techniques as well as inventory management techniques in general. Interviews of base level and higher headquarters staff personnel were used to gather data for the study. Additionally, an ABC Inventory Analysis was performed to identify high dollar volume inventory items which may merit closer management attention.

The procedures for identifying inventory requirements are examined. Inventory ordering, storage, and delivery practices are documented. The interfaces between medical materiel supply and its various sources of supply are outlined. The chain of supply was studied from the commercial origin of supplies, through the supply pipelines to the pharmacy, and, ultimately, to the patient.

Conclusions and recommendations are offered concerning management policies, inventory management procedures, order transmittal, and inventory delivery. Suggested uses of ABC Inventory Analysis results are provided. Finally, some recommendations for future research are offered.